The Role of DARPA in Seeding and Encouraging New Technology Trajectories: Pre- and Post-Tony Tether in the New Innovation Ecosystem

Erica Fuchs, Carnegie Mellon University, erhf@andrew.cmu.edu

With more and more jobs moving overseas, there has been rising concern over the ability of the U.S. to remain competitive in the global economy. In 2006, a committee from the National Academy of Sciences found a common "disturbing picture" across a multitude of industries, specifically, "a recurring pattern of abundant short-term thinking and insufficient long-term investment." Key among their recommendations was to "strengthen the nation's traditional commitment to long-term basic research that has the potential to maintain… the flow of new ideas that fuel the economy"(NationalAcademies, 2006).

The committee's recommendations are not surprising. In the earlier part of the 20th century, much R&D was still housed within corporate laboratories such as Bell Laboratories, GE Research, and Xerox Parc. In the 80s and 90s, with the rise of industrial clusters around Rt. 128 and Silicon Valley, research emerged suggesting key advantages to networked small and medium sized enterprises. Such enterprises were shown to be able to react more quickly to changing business environments, and to be more innovative than their larger, slower-moving counterparts. Today, many large firms outsource their innovation needs to universities and small firms through technology alliances and acquisitions. This industrial model may, however, have disadvantages for long-term innovation. Recent studies have demonstrated challenges in this new environment in the alignment of firm incentives (Casadesus-Masanell and Yoffie, 2005), in coordination across firms (Iansiti and Levien, 2004), and, in particular, in supporting long-term research (Macher et al., 2000). Critical will be understanding to what extent and in what form government policies may be necessary to support long-term innovation in this new environment.

To shed insights into this question, this study focuses on the Defense Advance Research Projects Association (DARPA) – a pioneer of the methods used by the U.S. developmental network state (Block, 2007) and one of the agencies to achieve some of the most striking early successes in technology development. Several factors make today a particularly interesting time to study DARPA. First, while DARPA has historically enjoyed significant success in introducing and commercializing new technologies, DARPA has under the directorship of Tony Tether (2001-2008) undergone momentous changes, which have faced significant criticism from the academic computing community. Given the shift of DARPA funding under Tether away from academia to established industry vendors, this criticism is not surprising. Second, leading up to this shift within DARPA, there have been significant changes in the industry structure, market structure, and R&D structure in computing. Thus, the changes within DARPA may be a necessary adjustment to changes in the computing industry and its innovation ecosystem. Finally, in the last decade a wealth of organizations have sprung up copying DARPA, aimed at technology development for other communities, outside the Department of Defense. Examples include Advanced Research and Development Activity (ARDA, 1998) and IARPA (2006) for the intelligence community, HSARPA (2002) for homeland security, and ARPA-E (2007) for the Department of Energy. With these recent developments, it seems imperative to look at the processes by which DARPA, historically, has encouraged new technology developments; what, over the years, about DARPA has changed and what has remained constant; and, most importantly, how DARPA's processes are working in today's innovation ecosystem.

To understand the processes by which DARPA influences innovation and how these processes may weather shifts in the external political, industrial, and technical environment, I

conduct a case study of DARPA's Microsystems Technology Office pre- (1992-2001) and post- (2001-2008) when Tony Tether took office in 2001. In executing the study, I triangulate participant observation, qualitative interview data, archival data, and bibliometric data to provide a holistic view of the forces driving technological change. The heart of my results draw from 50 semi-structured interviews with scientists and technologists (including DARPA program managers) involved in the development of technologies also funded by DARPA's Microsystems Technology Office between 1992 and 2008. I identified key scientists and technologists in this technical area through a snowball effect based on names mentioned in early interviews and in news documents. I cross-checked this list and identified additional DARPA program mangers involved in funding these technologies using DARPA's archives for the period. All together, I executed the interviews so as to ensure that they included (1) DARPA program managers from both before and after Tony Tether took the directorship in 2001, and (2) a representative cross-section of scientists and technologists from within academic institutions, start-ups, and the five established microprocessor vendors – Intel, AMD, IBM, HP, and Sun. I also asked each respondent to provide an up-to-date biography and CV, including a list of all of their publications and patents to-date in their career. I use these individual CVs to understand each interviewee's bibliometric record, as well as their co-patenting and co-publishing with other scientists.

The study has three main findings: First, DARPA's adaptability to changing political, environmental, and technical times is a critical, historically repeated capability enabled by the structure of the organization. Second, throughout organizational changes in DARPA, DARPA program managers continue to use the same five processes to seed and encourage new technology trajectories with the academic and industrial communities. These processes consist of (1) identifying technology directions by bringing together elite researchers in formal and informal brainstorming sessions, (2) gathering momentum around key ideas by providing seed funding to disparate researchers working on similar projects, (3) disseminating knowledge and creating community by forcing funded researchers to present their results to each other in workshops, (4) acting as third party validation of new technology directions to latter-stage funding agencies (like NSF) and to industry, and (5) not sustaining the technology. Third, although the recent shift in the focus of DARPA's efforts has received significant criticism from the academic community, DARPA may be effectively (1) narrowing the valley of death, (2) coordinating innovation within a vertically fragmented industry, and (3) influencing technology development to still serve military needs despite primary demand for computing having moved into commercial applications. This "new DARPA" may, however, leave the U.S. technology pipeline without new sources of innovation.

References

Block, F., 2007. "Swimming Against the Current: The Hidden Developmental State in the U.S." Politics and Society.

Casadesus-Masanell, R. and Yoffie, D. B., 2005. "Wintel: Cooperation and Conflict." Management Science **53**(4): 584-598.

Iansiti, M. and Levien, R., 2004. The Keystone Advantage: What the New Dynamics of Business Ecosystems mean for Strategy, Innovation, and Sustainability. Boston, Harvard Business School Press.

Macher, J., Mowery, D. and Hodges, D., 2000. Semiconductors. U.S. Industry in 2000. Mowery, D. C. Washington, D.C., National Academies Press**:** 245-286.

NationalAcademies, 2006. Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future. Washington, D.C., National Academies Press.